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Reported alcohol intake, diet and body mass index in male smokers

S Männistö[1], P Pietinen[1], J Haukka[2], M-L Ovaskainen[1], D Albanes[3] and J Virtamo[2]

[1] *Department of Nutrition, National Public Health Institute, Helsinki, Finland;* [2] *Cancer Prevention Unit, National Public Health Institute, Helsinki, Finland;* [3] *Cancer Prevention Studies Branch, National Cancer Institute, Bethesda, Maryland, USA*

Objective: The study was carried out to determine associations of reported alcohol intake with diet and body mass index. Type and frequency of consumed alcohol were also considered.
Design: A cross-sectional study.
Setting: The baseline examination of the participants of the Alpha-Tocopherol, Beta-Carotene Cancer Prevention Study in 1985–1988.
Subjects: 27 215 middle-aged Finnish male smokers.
Interventions: The diet was assessed by a self-administered food use questionnaire: Subject's habitual diet and alcohol intake over the previous 12 months were asked. Body mass index was used as the measure of adiposity.
Results: Energy intake from food was not related to alcohol intake. Although alcohol consumption was associated with food selection (eg berry and coffee consumption), this only slightly influenced daily nutrient intakes. Intake of spirits was more consistently related to higher body mass index than that of other alcoholic beverages. Daily alcohol intake had a much smaller association with body mass index than less frequent use, independently of the total consumption.
Conclusions: The differences in nutrient intake between abstainers, light and moderate alcohol consumers were small although the consumption of many foods varied with alcohol consumption. Even if alcohol consumption is one noteworthy factor associated with weight, the energy from alcohol increases body weight less than expected; both the type and frequency of consumed alcohol may explain why energy from alcohol is utilized less efficiently than nonalcoholic energy.
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Descriptors: alcoholic beverages, alcohol intake, body mass index, diet, energy

Introduction

There seems to be general agreement that light and moderate alcohol consumers do not habitually substitute food items with alcoholic beverages, but consume them in addition to normal food intake (Fisher & Gordon, 1985; Herbeth *et al*, 1988; Colditz *et al*, 1991; Veenstra *et al*, 1993). There are, however, conflicting reports from studies evaluating associations between alcohol intake and body mass index (Hellerstedt *et al*, 1990). Some findings have supported the logical assumption that light and moderate alcohol consumers have a higher body mass index (BMI) than abstainers. But in other studies the average BMI of alcohol drinkers has been lower than that of abstainers, despite higher total energy intakes. One possible explanations for this is that alcohol energy may be utilized less efficiently than nonalcoholic energy because of the microsomal ethanol oxidizing system (MEOS) (Pirola & Lieber, 1972); there is evidence that alcohol metabolized by MEOS generates only about 75% of energy compared with the alcohol dehydrogenase pathway (Lieber, 1991). Other hypotheses explain the lack of weight gain on the basis of increased dietary-induced thermic energy (Stock & Stuart, 1974), on drinkers having less regular dietary habits (Hillers & Massey, 1985), or on the interference of alcohol with macronutrient absorption (Gruchow *et al*, 1985). Little attention has been paid to associations between type or frequency of consumed alcohol and BMI.

Alcohol drinking habits in Finland differ from those in most other European countries. Drinking frequency tends to be low, usually only once or twice a week, but heavy consumption is common (Simpura *et al*, 1993). In contrast to the decline in many industrialized countries, alcohol intake increased in Finland at the end of the 1980s, following a period of particularly rapid economic growth. Although beer and wine consumption has increased proportionally until recently, spirits still account for one third of all purchased alcohol (The Finnish State Alcohol Company, 1993). In the 1980s

Correspondence: S Männistö.
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Finnish men have gained weight; in 1994 about 26% of adult males have a BMI of at least 27 kg/m^2 (Helakorpi *et al*, 1994).

We examined the associations between alcohol intake, diet and BMI among middle-aged male smokers participating in the Alpha-Tocopherol, Beta Carotene Cancer Prevention Study (ATBC Study) (The ATBC Cancer Prevention Study Group, 1994*a*,*b*). Our study concentrated on the role of alcohol in diet: whether there is substitution or addition, if alcohol intake alters food selection, and how strongly the energy from alcohol, or the type and frequency of alcohol intake, are associated with BMI.

Subjects and methods

The subjects of this study were participants in the ATBC Cancer Prevention Study, the main objective of which was to examine whether beta carotene or alpha-tocopherol prevents lung cancer (The ATBC Cancer Prevention Study Group, 1994*a*,*b*). A postal questionnaire asking about smoking habits and willingness to participate in the ATBC Study was sent to all men aged 50–69 living in southern and central Finland. Their names and addresses had been obtained from the National Population Register. The postal survey covered about 290 000 men altogether, of whom 79% replied; 54 000 of the respondents smoked at least five cigarettes per day and 79% (42 000) of these were willing to participate in the trial. After the exclusions (proven malignancy or other serious disease, alcoholism, regular supplement use of beta carotene, vitamin A or vitamin E or unwillingness to commit to a trial lasting 5–8 years), 29 246 men were enrolled in the ATBC Study. The data and safety monitoring committee of the ATBC Study was convened regularly to evaluate data relevant to safety and efficacy (The ATBC Cancer Prevention Study Group, 1994*a*).

A self-administered modified diet history (food use questionnaire) was used to assess the subject's habitual diet and alcohol intake over the previous 12 months (Pietinen *et al*, 1988). The usual consumption of about 200 food items and 70 mixed dishes was recorded. The alcohol items included beer, strong beer, wines, spirits and liqueurs. The participants were asked the number of times an item was routinely consumed per day, per week or per month, and a picture booklet with colour photographs was used to assess portion sizes. This questionnaire plus brief instructions on how to fill it in were given to the subjects by a nurse at the first visit, and returned during the second visit two weeks later when a nurse checked it through with the men. Each dietary questionnaire was then sent to the ATBC Study coordinating center where a nutritionist evaluated the reliability of the dietary data and decided on final approval. Accordingly, dietary data from 27 215 (93%) men were available for this study.

The reproducibility and validity of the questionnaire were tested in a pilot study in 1984 using food recording (24 days over six months) as a reference method (Pietinen *et al*, 1988). The reproducibility of the questionnaire varied from 0.56 for vitamin A to 0.88 for alcohol, with most values falling between 0.60 and 0.70. Intakes assessed by the questionnaire ranged from 87% to 147% (sucrose and vitamin C, respectively) of those measured by food record. The correlation between the questionnaire and food recording for total alcohol intake was 0.80.

Individual food consumption, daily energy and nutrient intakes were computed from the database of the National Public Health Institute. The food composition data are a mixture of values obtained from analysis of local food items, and from Finnish and international food composition tables. The nutrient contents of various alcoholic beverages were included in the daily nutrient intake, but alcohol was excluded when the percentage contribution of other energy nutrients to total energy was calculated. In this paper the term alcohol consumption refers to absolute alcohol intake. In the food composition data the intake of total fat is expressed in the traditional way, i.e. total fat contains other fat-soluble material in addition to triglycerides. However, fatty acids are analysed as pure fatty acids only (Hyvönen *et al*, 1993), so that these values are somewhat lower than when analysed by the traditional method. In addition to energy providing nutrients, intakes of vitamin A, vitamin E, thiamine, riboflavin, niacin, vitamin C, calcium, iron, magnesium, fiber and cholesterol were calculated.

For the analyses the subjects were divided into five alcohol consumption categories: 0 g, 0.1–14.9 g, 15–29.9 g, 30–59.9 g and at least 60 g per day, calculated as absolute alcohol. One alcohol portion includes about 12 g alcohol. Those who replied that they had consumed no alcohol during the past year were classified as abstainers and those who drank at least 30 g per day were considered heavy drinkers.

Subjects who reported that on average at least 50% of their alcohol intake was spirits were classified as spirit consumers (53% of the subjects). Those who reported at least half of their intake as beer were classified as beer consumers (26%). The third category included the rest of the alcohol consumers (10%). In addition, alcohol drinkers were divided into those who consumed alcohol daily (15%), or less frequently (85%).

Body mass index (BMI), weight (kg) divided by the square of height (m^2), was used as the measure of adiposity. Spare time activity was divided into three levels. Education was counted as the sum of years at school plus any kind of vocational education after that. Smoking was recorded as the average number of cigarettes smoked per day.

The dependence of BMI upon various explanatory variables was analyzed by ANOVA. The explanatory variables were categorized alcohol intake, type of beverages consumed, and frequency of alcohol usage (daily or less frequent). Four continuous variables were included as background variables: age, smoking, spare time activity and non-alcoholic energy intake. Nested design ANOVA was applied to the data: both the frequency of drinking and the type of alcohol beverages consumed were nested under alcohol intake categories.

Results

Alcohol consumption

Mean alcohol consumption was 18 g (s.d. 22) per day. Eleven per cent of the subjects were abstainers, and 20% heavy drinkers (at least 30 g daily). Alcohol con-

sumption was not normally distributed, since more than half of men (58%) consumed less than 15 g alcohol per day and the highest alcohol decile consumed 35% of all reported alcohol. The proportion of total alcohol consumption as pure alcohol by type of beverage was 56% for spirits, 36% for beer, 6% for wine and 2% for other drinks.

Cigarettes smoked daily were positively related to the amounts of alcohol consumed. Abstainers smoked 20 cigarettes per day on average, compared to 26 for those consuming at least 60 g alcohol daily. Alcohol consumption also increased with years of education: abstainers had on average one year less education than the heaviest drinkers. In contrast, alcohol was not related to leisure time activities.

Alcohol consumption, foods and nutrients

Mean energy intake increased with alcohol consumption (Figure 1). Total daily energy intake was 3232 kcal (1 kcal = 4.2 kJ) per day in the highest alcohol consumption category and 2754 kcal in abstainers, a difference of 478 kcal. When only energy from food was examined no marked differences were observed between alcohol intake categories; men in the highest alcohol category consumed 137 kcal less energy from food compared to the abstainers. Nonalcoholic energy percentages derived from protein (15–16%), fat (41–42%) and carbohydrates (42–44%) were also quite similar for all categories, indicating that alcohol was not substituted for food.

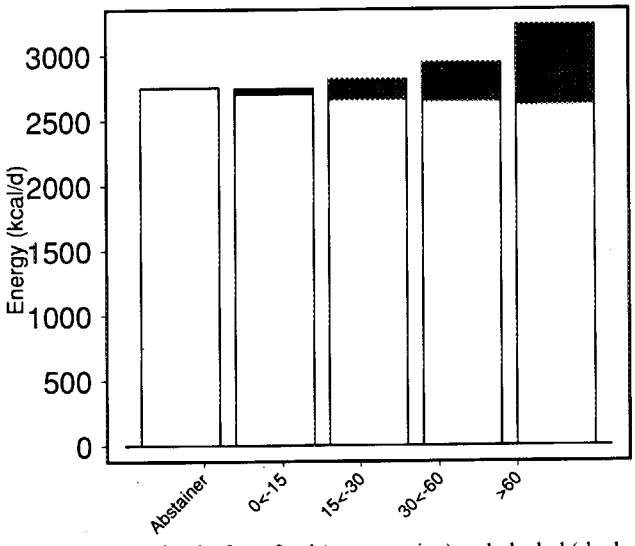

Figure 1 Energy intake from food (open portion) and alcohol (shaded portion) by alcohol consumption (g/day).

Daily food selection differed by level of alcohol consumption (Table 1). The intake of vegetables, fruit juices, beef, poultry, fish, tea and soft drinks increased with alcohol consumption by over 20% between the lowest and highest categories, whereas the consumption of wheat, other cereals, berries, fat milk, low fat milk, cream, coffee and sugar decreased by over 20%. The

Table 1 Mean daily food consumption (g) by level of alcohol consumption

	Alcohol (g/day)					
Food group	*Abst. (n = 3045)*	*0.1–14.9 (n = 12850)*	*15–29.9 (n = 6019)*	*30–59.9 (n = 4031)*	*60+ (n = 1270)*	*P-value*[a]
Increased with alcohol consumption						
Vegetables	71	81	85	88	86	<0.001
Fruit juices	21	23	26	26	31	<0.001
Cheese	23	25	26	27	27	<0.001
Soft Margarines	10	10	10	11	11	0.008
Oils	1.3	1.4	1.5	1.5	1.5	0.002
Pork	38	40	41	42	41	<0.001
Beef	22	25	27	28	28	<0.001
Poultry	10	12	13	14	13	<0.001
Sausages	74	71	79	80	83	<0.001
Fish	35	38	41	44	42	<0.001
Eggs	50	52	55	58	58	<0.001
Tea	64	73	74	77	86	<0.001
Soft drinks	99	90	114	140	164	<0.001
Decreased with alcohol consumption						
Rye	95	94	92	87	80	<0.001
Wheat	115	111	100	94	87	<0.001
Other cereals	21	20	17	17	14	<0.001
Roots	27	27	25	24	23	<0.001
Fruit	80	81	76	74	67	<0.001
Berries	39	41	35	30	26	<0.001
Fat milk	266	220	206	200	197	<0.001
Low fat milk	365	358	341	322	277	<0.001
Cream	18	16	15	14	14	<0.001
Butter	40	39	39	38	35	<0.001
Coffee	703	635	584	527	466	<0.001
Sugar	45	40	35	32	30	<0.001
Not associated with alcohol						
Potatoes	173	182	181	180	166	0.074
Sourmilk	152	159	162	156	158	0.456

[a] Test for trend.

Table 2 Mean daily nutrient intakes by level of alcohol consumption

Nutrient	*Alcohol (g/day)*					
	Abst. (*n* = 3045)	*0.1–14.9* (*n* = 12850)	*15–29.9* (*n* = 6019)	*30–59.9* (*n* = 4031)	*60+* (*n* = 1270)	*P-value*[a]
Total energy (kcal)[b]	2754	2746	2817	2942	3232	<0.001
Energy from food (kcal)[b]	2754	2703	2660	2647	2617	<0.001
Carbohydrate (g)	318	309	296	292	297	<0.001
Protein (g)	102	103	104	104	102	0.161
Fat (g)	124	123	123	123	119	0.068
Saturated fatty acids (g)	54	52	51	51	49	<0.001
Monounsaturated fatty acids (g)	35	35	35	36	35	0.050
Polyunsaturated fatty acids (g)	11	11	11	12	11	<0.001
Cholesterol (mg)	564	572	595	613	602	<0.001
Fiber (g)	27	26	25	24	22	<0.001
Vitamin A (μg)	2033	2192	2217	2247	2201	<0.001
Vitamin E (mg)	11	12	12	12	11	0.815
Thiamine (mg)	2.1	2.1	2.1	2.0	2.0	<0.001
Riboflavin (mg)	2.9	2.9	2.9	3.0	3.0	0.023
Niacin (mg)	39	39	40	42	46	<0.001
Vitamin C (mg)	104	108	106	103	98	<0.001
Calcium (mg)	1439	1406	1388	1375	1336	<0.001
Iron (mg)	19	19	18	18	17	<0.001
Magnesium (mg)	487	481	478	488	524	<0.001

[a] Test for trend.
[b] 1 kcal = 4.2 kJ.

consumption of alcohol was not related to that of potatoes or sour milk products. The trend of mean intake by category were independent of the level of education (data not shown).

The intake of niacin increased by more than 10% between the lowest and the highest alcohol categories, whereas saturated fatty acids, iron and fiber decreased by more than 10%. The consumption of alcohol was not related to the intake of protein, fat or vitamin E (Table 2). Average intakes of all measured nutrients were above the recommended values in all alcohol consumption categories, with one exception: vitamin C intake equalled the 100 mg recommended level for smokers (National Research Council, 1989).

Alcohol and body mass index

Average BMI was 26.3 kg/m^2 (s.d. 3.8) for all subjects combined, 26.0 kg/m^2 (s.d. 3.9) among abstainers and 26.3 kg/m^2 (s.d. 3.8) among alcohol drinkers. There was a positive association between alcohol consumption and BMI from abstainers to heavy drinkers. This association remained, although slightly weaker in upper

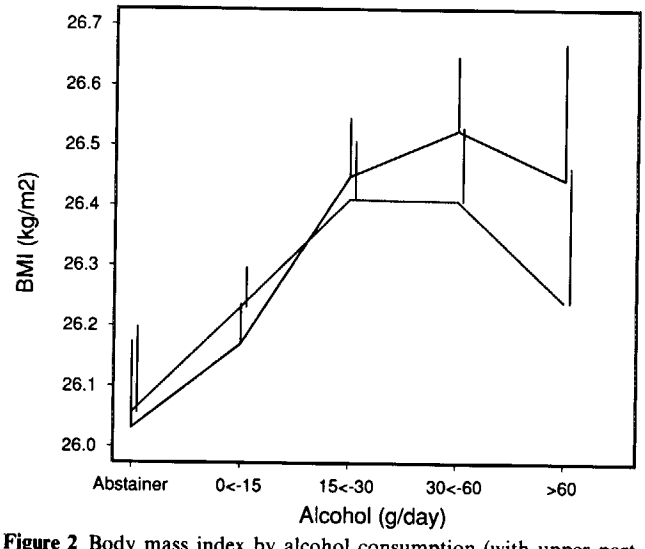

Figure 2 Body mass index by alcohol consumption (with upper part of 95% confidence interval). The solid line represents the unadjusted mean and the dotted line represents the mean adjusted for age, spare time activity, smoking and energy from food.

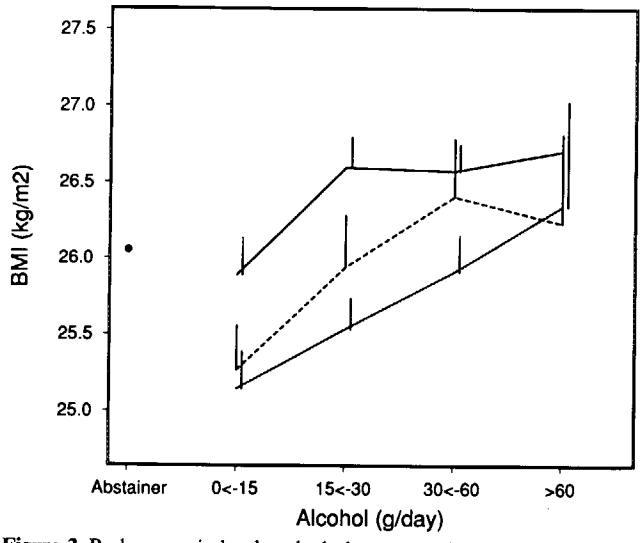

Figure 3 Body mass index by alcohol consumption (with upper part of 95% confidence interval) in abstainers, consumers of mostly spirits (solid line), beer (dotted line) or other types of alcohol (dashed line) adjusted for age, spare time activity, smoking and energy from food.

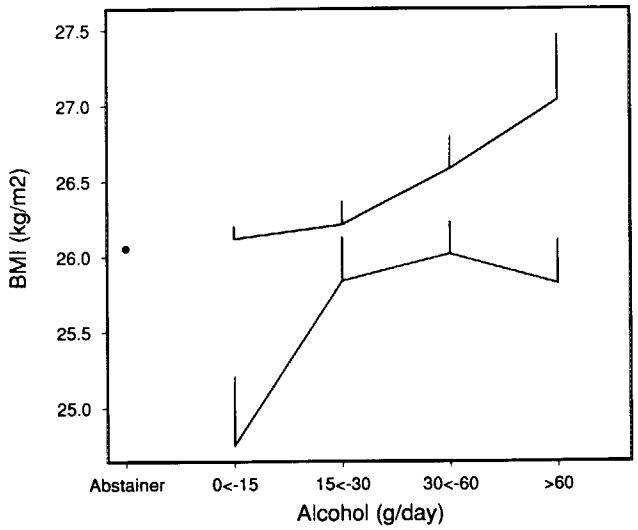

Figure 4 Body mass index by alcohol consumption (with upper part of 95% confidence interval) for non-daily (solid line) and daily (dotted line) drinkers adjusted for age, spare time activity, smoking and energy from food.

alcohol categories, after adjusting for age, spare time activity, smoking and nonalcoholic energy intake (Figure 2).

Spirit drinkers had a significantly higher mean BMI than consumers of other alcohol beverages. Furthermore, average daily total energy intake was 2850 kcal in men who drank spirits, 2774 kcal in beer consumers and 2803 kcal in mixed drinkers, while the average energy intake from food alone in spirits drinkers was 85 kcal higher than in beer drinkers and 46 kcal higher than in mixed drinkers. After adjustment for age, spare time activity, smoking and nonalcoholic energy intake, the association between alcohol type and BMI remained, with consumers of spirits having the highest BMI (Figure 3).

Average BMI was 25.8 kg/m^2 for daily drinkers and 26.4 kg/m^2 for non-daily drinkers. Daily alcohol drinkers were significantly leaner than others in all four alcohol consumption categories and they also had 100–200 kcal lower total energy intake (Figure 4). Even after adjusting for age, spare time activity, smoking and nonalcoholic energy intake, daily alcohol drinkers remained the leanest.

Discussion

Although this study sample was substantial, representing 10% of older men in the study areas, it was selected at many stages. Men were first asked about their smoking habits and willingness to join the trial. Only those who smoked at least five cigarettes per day were recruited, while men with severe disease, alcohol problems or poor motivation were excluded (The ATBC Cancer Prevention Study Group, 1994*a*). This selection needs to be born in mind when assessment of alcohol consumption among middle-aged Finnish men are made on the basis of this study. Moreover, all our subjects were smokers, who may have unhealthier diets than nonsmokers because unhealthy habits seem to accumulate in the same subjects (Le Marchand *et al*, 1988). Since there tends to be a positive association between smoking and alcohol consumption, i.e. smoking is more common among heavy drinkers, the lack of nonsmokers in this study may have disproportionately affected the results concerning abstainers and moderate drinkers.

The men in this study consumed an average of 6.9 litres absolute alcohol a year. According to official statistics the per capita consumption of alcoholic beverages was 6.9 litres in Finland in 1986, while consumption calculated per adult was 9.0 litres (The Finnish State Alcohol Company, 1987). In the 1980s, consumption not included in the official statistics was estimated at one tenth of total alcohol consumption. However, in most previous drinking habit studies in Finland subjects have forgotten or underestimated their alcohol drinking to the extent that the reported intake was less than half of the figure in official statistics (Simpura *et al*, 1993).

Total energy intake increased with rising alcohol consumption but there were no differences in the nonalcoholic energy intakes between alcohol consumption categories. Alcohol was added to the diet, and did not seem to substitute for food items. Our results are in agreement with findings from other studies using samples of general populations (Fisher & Gordon, 1985; Herbeth *et al*, 1988; Colditz *et al*, 1991; Veenstra *et al*, 1993).

It is difficult to compare our results concerning the selection of foods with findings from France (Herbeth *et al*, 1988), Hawaii (Le Marchand *et al*, 1989) and Italy (La Vecchia *et al*, 1992) because of cultural differences. However, in those studies meat consumption rose and fruit consumption fell with increasing alcohol intake. A negative relationship between coffee and alcohol consumption has also been detected in other studies (Le Marchand *et al*, 1989; La Vecchia *et al*, 1992). In this study men who consumed at least 60 g absolute alcohol per day drank 2.5 dl less coffee than abstainers. Coffee and alcohol may be competitors in the diet (Le Marchand *et al*, 1989). One explanation is that heavy alcohol consumers very often suffer from stomach ache, which may decrease their coffee consumption. In contrast to the other three studies, we found no association between dietary fat intake and alcohol consumption. Our study subjects were smoking men at least 50 years old whose dietary habits may be unhealthier than those of non-smokers.

An inverse or U-shaped association between alcohol consumption and coronary heart disease is quite well established (see Moore & Pearson, 1986; Rimm *et al*, 1991), although it still lacks elucidation. Shaper *et al* (1988) has argued that it could be due to contamination of the abstainer category by men who have reduced alcohol consumption because of pre-existing disease or alcohol problems. Another explanation is that alcohol increases the HDL/LDL cholesterol ratio (see Moore & Pearson, 1986). Alcohol consumption could also be associated with changes in diet, especially with fat and carbohydrate intakes (Jones *et al*, 1982). The results of this study do not support this hypothesis, since the diet of moderate drinkers was not healthier than that of abstainers.

Pirola & Lieber (1972) found that isocaloric substitution of carbohydrates by alcohol for 16 days resulted in a significant weight loss in 12 hospitalized alcoholics. He suggested that energy from alcohol is inefficient due

to the activation of energy wasting metabolic pathways such as the microsomal ethanol oxidizing system (MEOS). After that study it was frequently found that alcohol consumers weighed the same or less than abstainers despite their higher total energy intake (Gruchow *et al*, 1985; Le Marchand *et al*, 1989; Jones *et al*, 1982; Williamson *et al*, 1987), while others reported higher weight among alcohol consumers compared to abstainers (Lang *et al*, 1987; Trevisan *et al*, 1987). The present study showed a positive association between alcohol consumption and BMI; however the BMI of men who consumed at least 60 g alcohol per day was only 0.4 kg/m^2 higher (or approximately 1.6 kg for a 180 cm man) than that of abstainers, while their total daily energy intake was 478 kcal higher. Moreover, heavy drinkers were not more physically active than others. Thus our results support, at least to some extent, the finding of Pirola & Lieber (1972) that alcohol energy is not utilized as efficiently as other calories. Alternatively, it is possible that heavy alcohol consumers tend to overreport their food intake, since they may focus on food consumption habits during their sober days. Support for this comes the study by Hillers & Massey (1985); middle-class men who were classified into the upper tertile of alcohol drinking habits reported that during alcohol drinking days they tended to eat less food and skip meals.

It is possible that different effects of alcohol beverages are not caused by the same main component (ethanol) but by their other characteristic components (Dorfman *et al*, 1985). Thus the type and frequency of consumed alcohol may also help to explain the association between alcohol and BMI. Beer drinking is thought to contribute to obesity. Belfrage *et al* (1973) showed that seven out of eight young beer drinkers gained weight during a 5-week experiment in which they consumed 63 g alcohol per day. It has also been suggested that wine differs from other alcoholic beverages and may have beneficial effects on metabolism (Grønbæk *et al*, 1995). Flavonoids, phenolics and other phytochemicals in plant foods and red wine may reduce oxidative reactions, thereby retarding the onset and progress of many common chronic diseases, according to a review by Kinsella *et al* (1993).

In Finland, alcohol consumption tends to be concentrated at weekends and special occasions; many working class men, for instance, have a habit of buying a 'Friday night bottle' of spirits which is consumed that night mainly in order to get drunk. However, most of these men do not use alcohol during the working week. It may be that such drinking habits do not sustain the MEOS wasting system for alcoholic energy. This is supported by our finding that adjusted BMI was higher for irregular alcohol drinkers than for daily drinkers at every level of alcohol consumption. It also agrees with the finding that consumers of spirits had the highest BMI, since irregular alcohol use usually involves spirits, whereas daily drinkers mostly consume beer or wine. Irregular alcohol use may also be associated with reporting difficulties during drinking days.

This study, as with recent reports, indicates that alcohol is consumed with its energy load in addition to the normal diet, and that the intake of nutrients is adequate in all alcohol consumption categories compared to recommended RDA values. It is possible that increased alcohol consumption may have contributed to the recent weight gain among Finnish men. However, among the subset of men who use alcohol daily, energy from alcohol seems to be less efficiently used in metabolism than other energy.

References

The ATBC Cancer Prevention Study Group (1994*a*): The Alpha-Tocopherol, Beta Carotene Lung Cancer Prevention Study: Design, methods, participant characteristics and compliance. *Ann. Epidemiol.* **4**, 1–10.

The ATBC Cancer Prevention Study Group (1994*b*): The effect of vitamin E and beta carotene on the incidence of lung cancer and other cancers in male smokers. *N. Engl. J. Med.* **330**, 1029–1035.

Belfrage P, Berg B, Cronholm T, Elmqvist D, Hägerstrand I, Johansson B, Nilsson-Ehle P, Norden G, Sjövall J & Wiebe T (1973): Prolonged administration of ethanol to young, healthy volunteers: effects on biochemical, morphological and neuro-physiological parameters. *Acta. Med. Scand.*, Suppl. **552**, 5–43.

Colditz GA, Giovannucci E, Rimm EB, Stampfer MJ, Rosner B, Speizer FE, Gordis E & Willett WC (1991): Alcohol intake in relation to diet and obesity in women and men. *Am. J. Clin. Nutr.* **54**, 49–55.

Dorfman A, Kimball AW & Friedman LA (1985): Regression modeling of consumption or exposure vaiables classified by type. *Am. J. Epidemiol.* **122**, 1096–1107.

The Finnish State Alcohol Company (1987): *Alcohol statistical yearbook 1986*. Helsinki: Government Printing Office.

The Finnish State Alcohol Company (1993): *Alcohol statistical yearbook 1992*. Helsinki: Government Printing Office.

Fisher M & Gordon T (1985): The relation of drinking and smoking habits to diet: the Lipid Research Clinics Prevalence Study. *Am. J. Clin. Nutr.* **41**, 623–630.

Gruchow HW, Sobocinski KA, Barboriak JJ & Scheller JG (1985): Alcohol consumption, nutrient intake and relative body weight among US adults. *Am. J. Clin. Nutr.* **42**, 289–295.

Grønbæk M, Deis A, Sørensen TIA, Becker U, Schnohr P & Jensen G (1995): Mortality associated with moderate intakes of wine, beer, or spirits. *Br. Med. J.* **310**, 1165–1169.

Helakorpi S, Berg M-A, Uutela A & Puska P (1994): *Health behaviour among Finnish adult population, spring 1994*. Helsinki: Publications of the National Public Health Institute, B8.

Hellerstedt WL, Jeffery RW & Murray DM (1990): The association between alcohol intake and adiposity in the general population. Reviews and commentary. *Am. J. Epidemiol.* **132**, 594–611.

Herbeth B, Didelot-Barthelemy L, Lemoine A & Le Devehat C (1988): Dietary behaviour of French men according to alcohol drinking pattern. *J. Stud. Alcohol* **49**, 268–272.

Hillers VN & Massey LK (1985): Interrelationships of moderate and high alcohol consumption with diet and health status. *Am. J. Clin. Nutr.* **41**, 346–362.

Hyvönen L, Lampi A-M, Varo P & Koivistoinen P (1993): Fatty acid analysis, TAG equivalents as net fat value, and nutritional attributes of commercial fats and oils. *J. Food Comp. Anal.* **6**, 24–40.

Jones BR, Barrett-Connor E, Criqui MH & Holdbrook MJ (1982): A community study of calorie and nutrient intake in drinkers and nondrinkers of alcohol. *Am. J. Clin. Nutr.* **35**, 135–139.

Kinsella JE, Frankel E, German B & Kanner J (1993): Possible mechanisms for the protective role of antioxidants in wine and plant foods (review). *Food Technol.* **47**, 85–89.

Lang T, Degoulet P, Aime F, Devries C, Jacquinet-Salord MC & Fouriaud C (1987): Relationship between alcohol consumption and hypertension prevalence and control in a French population. *J. Chronic. Dis.* **40**, 713–720.

La Vecchia C, Negri E, Franceschi S, Parazzini F & Decarli A (1992): Differences in dietary intake with smoking, alcohol and education. *Nutr. Cancer* **17**, 297–304.

Le Marchand L, Ntilivamunda A, Kolonel LN, Vanderford MK & Lee J (1988): Relationship of smoking to other life-style factors among several ethnic groups in Hawaii. *Asian-Pac. J. Public Hlth* **2**, 120–126.

Le Marchand L, Kolonel LN, Hankin JH & Yoshizawa CN (1989): Relationship of alcohol consumption to diet: a population-based study in Hawaii. *Am. J. Clin. Nutr.* **49**, 567–572.

Lieber CS (1991): Perspectives: do alcohol calories count? *Am. J. Clin. Nutr.* **54**, 976–982.

Moore RD & Pearson TA (1986): Moderate alcohol consumption and coronary artery disease (a review). *Medicine* **65**, 242–267.

National Research Council (1989): *Recommended dietary allowances*, 10th edn. Washington, DC: National Academy Press.

Pietinen P, Hartman AM, Haapa E, Räsänen L, Haapakoski J, Palmgren J, Albanes D, Virtamo J & Huttunen JK (1988): Reproducibility and validity of dietary assessment instruments I: A self-administered food use questionnaire with a portion size picture booklet. *Am. J. Epidemiol.* **3,** 655–666.

Pirola RC & Lieber CS (1972): The energy cost of the metabolism of drugs, including ethanol. *Pharmacology* **7,** 185–196.

Rimm EB, Giovannucci EL, Willett WC, Colditz GA, Ascherio A, Rosner B & Stampfer MJ (1991): Prospective study of alcohol consumption and risk of coronary disease in men. *Lancet* **338,** 464–468.

Shaper AG, Wannamethee G & Walker M (1988): Alcohol and mortality in British men: explaining the U-shaped curve. *Lancet* **ii,** 1267–1273.

Simpura J, Mustonen H & Paakkanen P (1993): New beverages and new drinking contexts. Changes in Finnish drinking patterns in 1984–1992, compared with EC countries (in Finnish with English summary). *Alkoholipolitiikka* **58,** 245–258.

Stock MJ & Stuart JA (1974): Thermic effects of ethanol in the rat and man. *Nutr. Metab.* **17,** 297–305.

Trevisan M, Krogh V, Farinaro E, Panico S & Mancini M (1987): Alcohol consumption, drinking pattern and blood pressure: analysis of data from the Italian National Research Council Study. *Int. J. Epidemiol.* **16,** 520–527.

Veenstra J, Schenkel JAA, van Erp-Baart AMJ, Brants HAM, Hulshof KFAM, Kistemaker C, Schaafsma G & Ockhuizen Th (1993): Alcohol consumption in relation to food intake and smoking habits in the Dutch National Food Consumption Survey. *Eur. J. Clin. Nutr.* **47,** 482–489.

Williamson DF, Forman MR, Binkin NJ, Gentry EM, Remington PL & Trowbridge FL (1987): Alcohol and body weight in United States adults. *Am. J. Public Hlth* **77,** 1324–1330.